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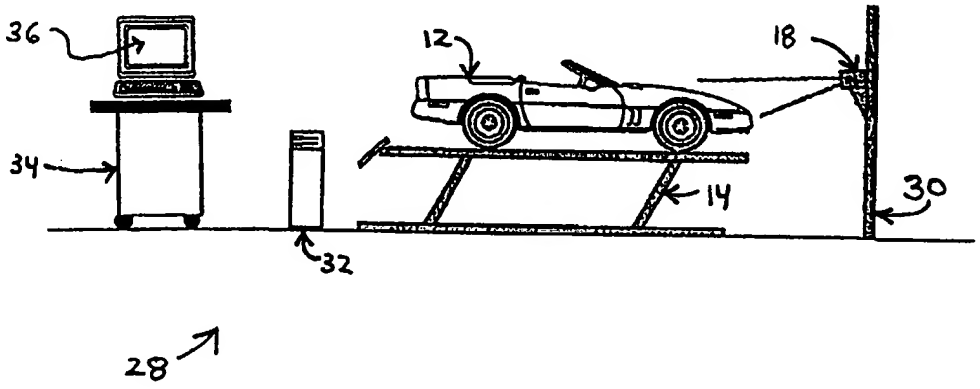
(54) Title: APPARATUS AND METHOD FOR ADJUSTING WHEEL ALIGNMENT CAMERA HEIGHT



(57) Abstract

Apparatus (30) and method for adjusting the height of wheel alignment cameras (20, 22) includes elevating camera supports for supporting the wheel alignment cameras (20, 22) and adjusting the vertical position of the cameras (20, 22). The wheel alignment cameras (20, 22) provide signals that correspond to the field of view to a processor (34) which provides display signals to a display (36). A camera height control console provides for manual adjusment of camera height.

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APPARATUS AND METHOD FOR ADJUSTING WHEEL ALIGNMENT CAMERA HEIGHT

CROSS REFERENCE TO RELATED APPLICATION

This application claims priority to U.S. provisional application Serial No. 60/052,181, filed July 10, 1997, entitled "Camera Lift for the 'Visualiner 3D' Wheel Aligner."

BACKGROUND OF THE INVENTION

The present invention relates to a camera lift for use with an optical wheel alignment system and more particularly to a camera lift system that provides a display of the field of view of wheel alignment cameras and provides means for an operator to adjust the height of wheel alignment cameras.

In optical wheel alignment systems, one or more cameras are used to develop signals from targets that connect to the vehicle. See U.S. Patent No. 5,724,743, entitled Method and Apparatus for Determining the Alignment of Motor Vehicle Wheels. In an optical wheel alignment system, the position of the alignment cameras must remain substantially constant throughout a wheel alignment test. Therefore, the cameras and the horizontal beam upon or within which the cameras are mounted (hereinafter "camera bar") remain in a fixed position at a fixed height at most times. Movement of the camera bar is avoided. To further prevent movement of the camera bar during alignment tests, the

camera bar is secured to a stationary object. Routine camera bar height adjustments have heretofore been impractical. Nevertheless, to perform a wheel alignment test, the images on the wheel targets must be fully within the view of the alignment cameras. In prior art optical wheel alignment systems, the height of a vehicle lift is adjusted through a control panel for a hydraulic or other mechanical system until the images on the wheel targets appear to be fully within view of the wheel alignment cameras.

In the prior art system described above, alignment adjustments are made to a vehicle at a lift height necessitated by the position of the camera bar. This provides the mechanic the benefit of observing changes in alignment parameters on a display provided by the optical alignment system as adjustments are made to the vehicle. The height required for the alignment system may not, however, correspond to the height that is most convenient or desirable for the mechanic or for performing the necessary repairs. This inconvenience may have costs, such as inefficient use of the mechanic's time or less than adequate service.

One system for adjusting the height of a wheel alignment camera bar is disclosed in U.S. Patent No. 5,675,515. The camera elevating mechanism disclosed therein maintains the position of optical targets with respect to the field of view of the cameras as the vehicle lift and vehicle are elevated. However, the elevating system disclosed operates under the control of a computer and does not allow the mechanic to control the position of the camera bar with respect to the target images and does not provide a display so that the mechanic can observe the position of the target images from the perspective of the cameras. If the mechanic believes that the alignment parameters provided by the system are in error, no means are provided to verify that the cameras have a target image fully within the field of view. In addition, the mechanic cannot readily determine whether a target image or target image path is free of optical obstacles.

SUMMARY OF THE INVENTION

Therefore it is an object of this invention to allow a mechanic to adjust the height of a lift in a wheel alignment system to a desired working level by providing a device that

enables the mechanic to readily adjust and change the height of the camera bar.

It is a further object of this invention to provide the mechanic with an indication of the relative height of the camera bar to the images on wheel targets and thus provide information to assist the mechanic when adjusting the height of the camera bar.

It is yet another object of this invention to allow the mechanic to adjust the position of the images of wheel targets with respect to the field of view of alignment cameras.

Another object of this invention is to provide a display of an image in the view of an alignment camera so that a mechanic can readily determine whether the line of sight from the camera to the image is sufficiently clear.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an illustration of a prior art wheel alignment system with a vehicle and vehicle lift.

Fig. 2 is an illustration of a wheel alignment system that includes the camera lift system of the present invention.

Figs. 3a-c are illustrations of various displays provided by the camera lift system of the present invention.

Fig. 4 is an illustration of a vehicle lift and camera lift control console of the present invention.

Fig. 5 is an illustration of an elevating camera support system of the present invention in a first position.

Fig. 6 is an illustration of an elevating camera support system of the present

invenion in a second position.

Fig. 7 is an illustration of an elevating camera support of the present invention.

Fig. 8 is similar to Fig. 7, illustrating the components of the elevating camera support.

Fig. 9 is a block diagram of one embodiment of the present invention.

Fig. 10 is a block diagram of an alternate embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

An optical wheel alignment system 10 of the prior art is illustrated in Fig. 1. A vehicle 12 rests upon a vehicle lift 14. Right side wheel targets 16 and 17 are attached to the right front and rear wheels, respectively, of vehicle 12. Corresponding left side wheel targets, not shown, are also attached to the wheels on the left side of vehicle 12. Camera bar assembly 18 includes a right camera 22 for viewing the wheel targets 16 and 17 on the wheels on the right side of vehicle 10 and a left camera 20 for viewing the wheel targets on the left side, not shown, of vehicle 10. Cameras 20 and 22 optically view images of or on the wheel targets and provide optical signals in response thereto. An electronic processor such as a computer 24 receives the optical signals from cameras 20 and 22, processes the signals, calculates alignment parameters and provides alignment data display signals for display on display 26. The displays are preferably orientated so that the mechanic can view the alignment parameters as adjustments are made to the vehicle. U.S. Patent No. 5,724,743 discloses a wheel aligner system of the type just described and is incorporated herein by reference.

Referring to Figs. 2 and 9, a wheel alignment system 28 including an apparatus for adjusting the height of an alignment camera of the present invention is disclosed. An elevating camera support system 30 includes a camera bar 18 which is shown as extending

horizontally in this embodiment but which could be oriented in any direction, provided the camera or cameras are able to view both sides of the vehicle. The vertical position of camera bar 18 is adjustable with respect to the elevating camera support system 30. A vehicle lift 14 supports a vehicle 12 having wheel targets, not shown, attached thereto. Wheel targets are shown in Fig. 11 of USPN 5,724,743. Control system 32 provides means to manually adjust the height of vehicle lift 14 and camera bar 18. A processor system 34 receives signals from camera bar 18 and provides display signals for display on display 36 Display 36 may be a CRT display, an LCD, a video display, or any other visual display. Processor system 34 may be independent of or, alternatively, associated with the processor disclosed in U.S. Patent No. 5,675,515.

Referring to Fig. 5, an elevating camera support system 30 that includes elevating camera supports 48 and 50 is shown. Camera bar 18 includes right and left alignment cameras 22 and 20, respectively. Elevating camera support 50 is shown in Figs. 7 and 8. Vertical movement of camera bar 18 is actuated by an electrical motor or other device 56 attached to a chain or other mechanism such as a screw or spring, not shown. In the preferred embodiment, the chain is attached to a mounting assembly 58 comprised of a slider 64 and mount 66. Slider 64 is vertically moveable within vertical apertures 60 and 62 formed in vertical support 54. Camera bar 18 is secured to mount 66. Electrical motor 56 is attached to the top of vertical support 54 and is activated manually by control system 32.

In an alternate embodiment, only one elevating camera support supports camera bar 18. In one version of this design, the center of camera bar 18 is attached to mount 66.

As shown in Fig. 4, control system 32 includes vehicle lift control console 44 and camera height control console 46. In the present embodiment, camera height control console 46 is attached to the side of vehicle lift control console 44. Camera height control console 46 is comprised of a camera height control switch 68, a camera height high button 70 and a camera height low button 72. In the preferred embodiment, activation of camera height high button 70 moves camera bar 18 to a height of about 8 feet above ground level.

Activation of camera height low button 72 moves the camera bar 18 to a height of about 2 feet above ground level. Camera height control switch 68 can be manually activated to move the camera bar to any height from the absolute high position of Fig. 5 to the absolute low position of Fig. 6 or to any position in between. In a first alternate embodiment, vehicle lift control console 44 is located near the bay doors of the maintenance area and camera height control console 46 is located on the cabinet of computer 34. In a second alternate embodiment, camera height control console 46 is wireless, powered by battery, and communicates via Radio Frequency (RF) or Infrared (IR) signals.

Referring to Figs. 2 and 3, operation of the wheel alignment system 28 will be described. Vehicle 12 is driven onto vehicle lift assembly 14. Wheel targets, not shown, are attached to each wheel of the vehicle. Next, the mechanic manually activates vehicle lift control 44 to move vehicle 12 to a desired height. The mechanic then decides whether to monitor the field of view of camera 20, camera 22, or both and inputs his selection to computer 34. The mechanic then activates camera height control switch 68 and camera bar 18 moves in the vertical direction while the mechanic monitors the display on display 36. In the present embodiment, display 36 provides a view of the field of view of both right camera 20 and left camera 22. As the camera height approaches the height of the wheel targets, the images on the wheel targets will begin to appear on display 36. By observing the position of the images on the display, the mechanic can determine whether a target is within the field of view of the camera. The mechanic continues to adjust the camera height so that the target images are completely within the field of view of the camera and do not overlap. If the mechanic believes that further raising or lowering of the vehicle may be required, the target image may be positioned low (or high) in the field of view of the camera.

At times, the mechanic may receive alignment data that he may believe to be in error. Further, the mechanic may not know the reason for the error. The mechanic may check the integrity of the wheel targets and camera by viewing display 36. The display allows the mechanic to identify blockages in the camera optical path and detect dirt

accumulation on the surfaces of the targets. A display that does not show a complete and clear image of the targets may indicate that the camera height is incorrect, as shown in Figs. 3(b) and 3(c), or that there is a problem with the camera assembly or a wheel target. A display showing target images within the field of view of the cameras is illustrated in Fig.3(a).

In another embodiment of the present invention, one set of controls is used to operate the vehicle lift and the camera lift, as shown in Fig. 10. In this embodiment, a display is not needed because the height of the camera bar assembly with respect to the vehicle targets remains fixed. However, a display may be provided to initially verify that the vehicle targets are within the field of view of the cameras.

In yet another embodiment, a limited number of preferred heights for the vehicle lift are initially designated and marked. The field of view display is used to designate corresponding camera lift heights, which are also marked. Thereafter, the vehicle lift and camera lift are raised directly to the preferred heights using the vehicle lift control and camera lift control. In this embodiment, after the vehicle and camera lift heights have been marked, the mechanic does not have to rely upon the display to ensure that the target images are within the field of view of the cameras. Rather, the vehicle and camera lifts are raised to discrete, predetermined positions.

In still another embodiment, the camera bar is mechanically attached to the vehicle lift.

In a further embodiment, the camera lift has a plurality of opto-electric emitters/sensors, 74, 76, and 78, attached thereto, as shown in Fig. 11. Vehicle lift 14 has a mirror 80 attach thereto. Each opto-electric emitter emits a light beam in the horizontal direction. Mirror 80 reflects at most one opto-electric light beam back to the camera lift to a corresponding opto-electric sensor. The opto-electric sensor that receives the light beam sends a signal to camera lift control device 82. Camera lift control device 82 may be a microcomputer or may operate under hardware control. As illustrated in Fig. 12, if

opto-electric sensor 76 receives a light beam, control device 82 does not adjust the height of the camera bar. If opto-electric sensor 74 receives a light beam, control device 82 provides a signal to the camera lift assembly 30 to raise the height of the camera bar. If opto-electric sensor 78 receives a light beam, control device 82 provides a signal to the camera lift assembly 30 to lower the height of the camera bar.

An alternative to the previous embodiment includes a pair of linear transducers 84 and 86, as shown in Fig. 13. Linear transducer 86 provides to control device 82 a signal corresponding to the vertical position of vehicle lift 14 and linear transducer 84 provides to control device 82 a signal corresponding to the vertical position of the camera bar 18. An predetermined offset distance between the vehicle lift and the camera bar is input into control device 82. As the vertical position of vehicle lift 14 is adjusted, linear transducer provides a corresponding signal to control device 82. Control device 82 activates camera lift assembly 30 to lower or raise camera bar 18 accordingly. Linear transducer 84 provides a signal corresponding to the adjusted position of the camera bar 18 to the control device 82. Control device 82 deactivates camera lift assembly 30 when the vertical distance between the vehicle lift and camera bar reaches the predetermined offset distance.

Although the present invention has been described with reference to preferred embodiments, those skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention.

WHAT IS CLAIMED IS:

Claim 1. An apparatus for adjusting the height of a wheel alignment camera for viewing wheel alignment targets attached to a vehicle and providing field-of-view signals thereof, comprising:

at least one elevating camera support for supporting said camera;

a drive system associated with said elevating camera support for adjusting the height of said camera;

a microprocessor for receiving said field-of-view signals and providing display signals therefrom;

a display for receiving said display signals and providing a display of said field-of-view of said wheel alignment camera;

a control console in communication with said drive system for selectively and manually activating said drive system.

Claim 2. An apparatus for adjusting the height of a wheel alignment camera for viewing wheel alignment targets attached to a vehicle, comprising:

elevating camera supports for supporting said camera;

a drive system associated with said elevating camera supports for adjusting the height of said camera;

a control console in communication with said drive system for selectively and manually activating said drive system.

Claim 3. An apparatus for displaying field-of-view signals provided by a wheel alignment camera for viewing wheel alignment targets attached to a vehicle, comprising:

a microprocessor for receiving said field-of-view signals and providing display signals therefrom;

a display for receiving said display signals and providing a display of said field-of-view of said wheel alignment camera.

Claim 4. A method for vertically aligning the line of sight of a wheel

alignment camera having a field of view and supported by at least one camera elevating support, with an image on a wheel target attached to a vehicle supported by a vehicle lift, comprising the steps of:

providing a display of said field of view;

adjusting the height of said wheel alignment camera on said camera elevating support until said image is completely within said display.

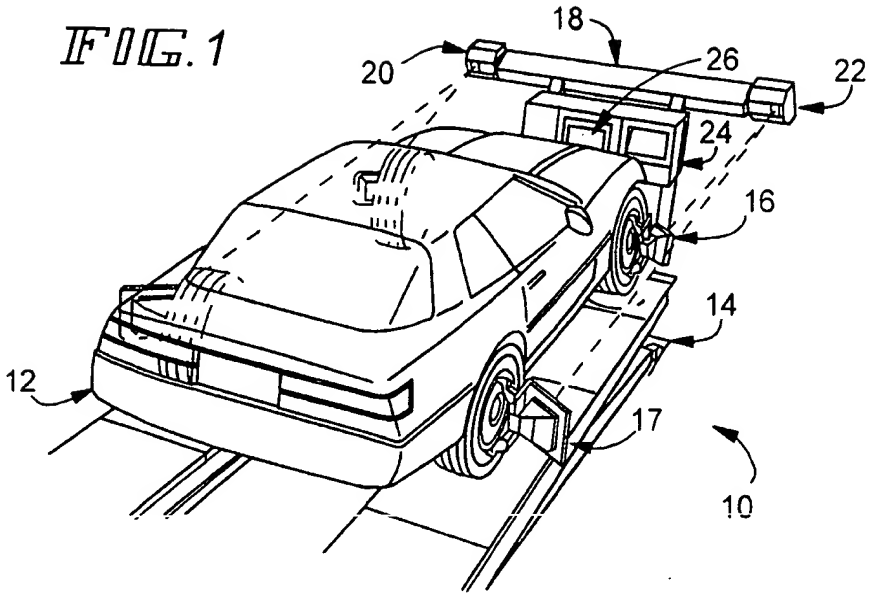
Claim 5. A method for adjusting the height of a wheel alignment camera, supported by a camera boom, relative to an automobile, with wheel targets thereon, on a vehicle lift comprising the steps of:

viewing a position of said wheel targets to said wheel alignment camera and developing a display signal indicative of said position;

providing said display signal to a display for displaying said indication of said position on a display;

observing said display and activating control means for adjusting the height of said wheel alignment camera based upon said display.

FIG. 1



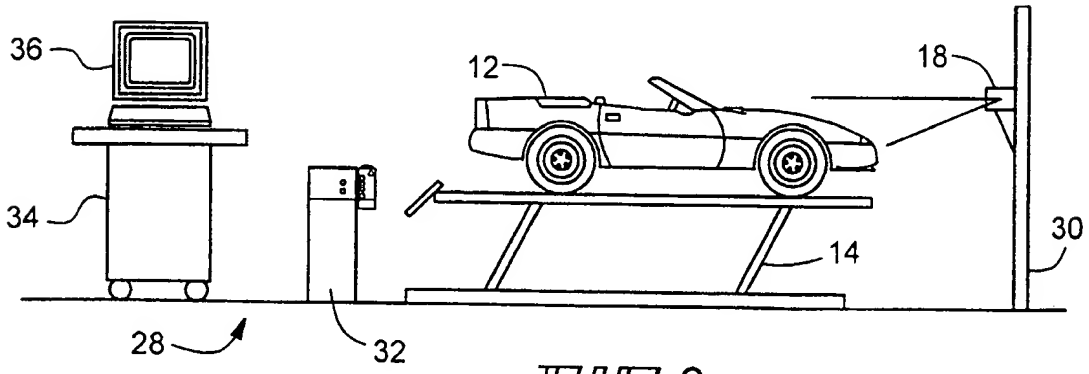


FIG. 2

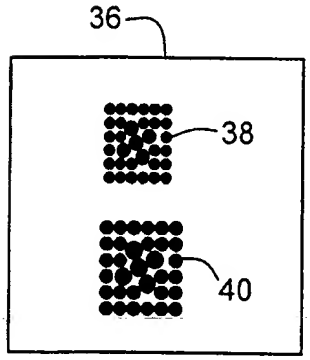


FIG. 3a

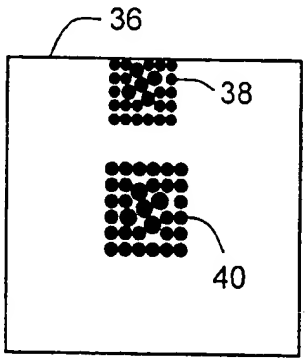


FIG. 3b

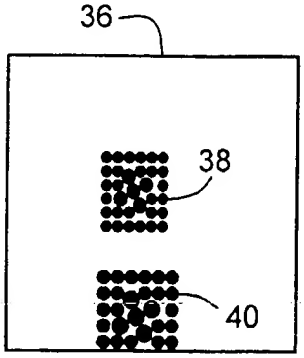


FIG. 3c

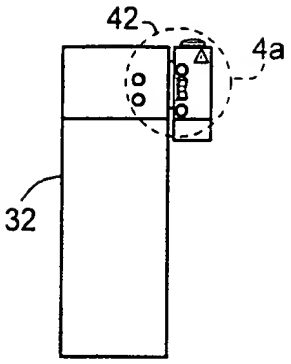


FIG. 4

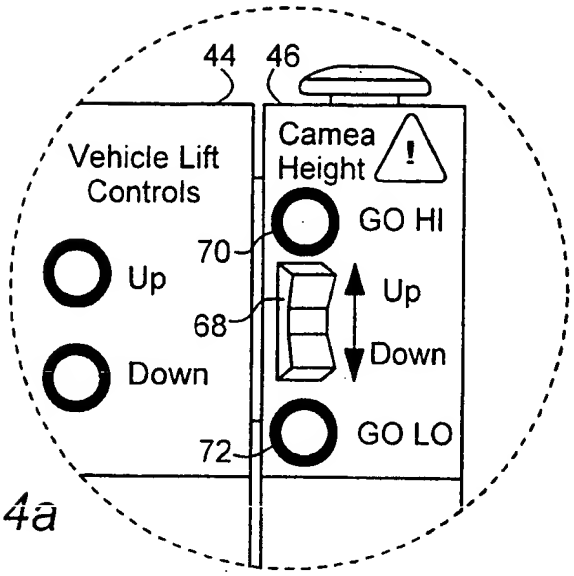
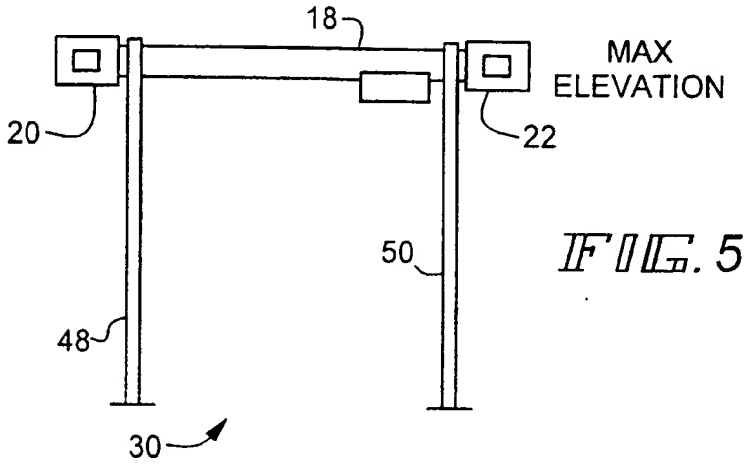


FIG. 4a



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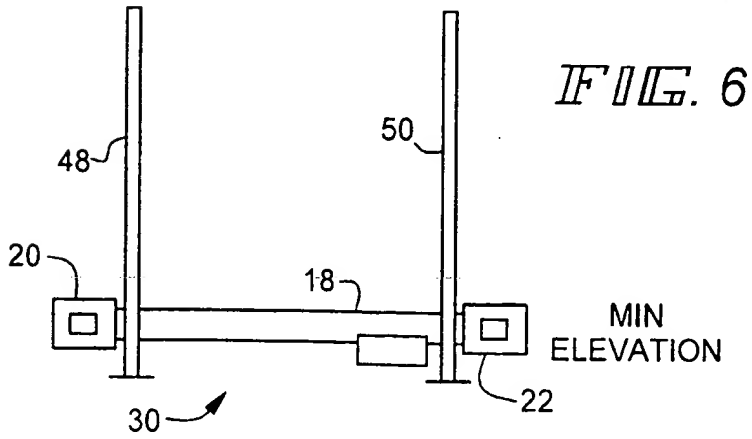


FIG. 6

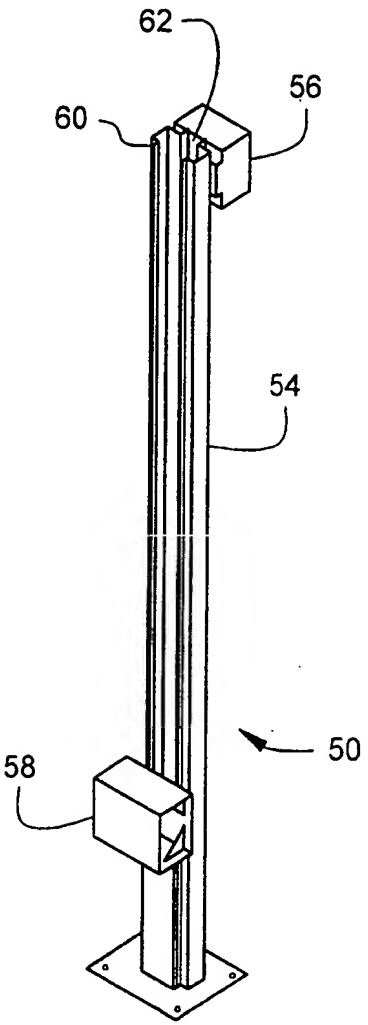


FIG. 7

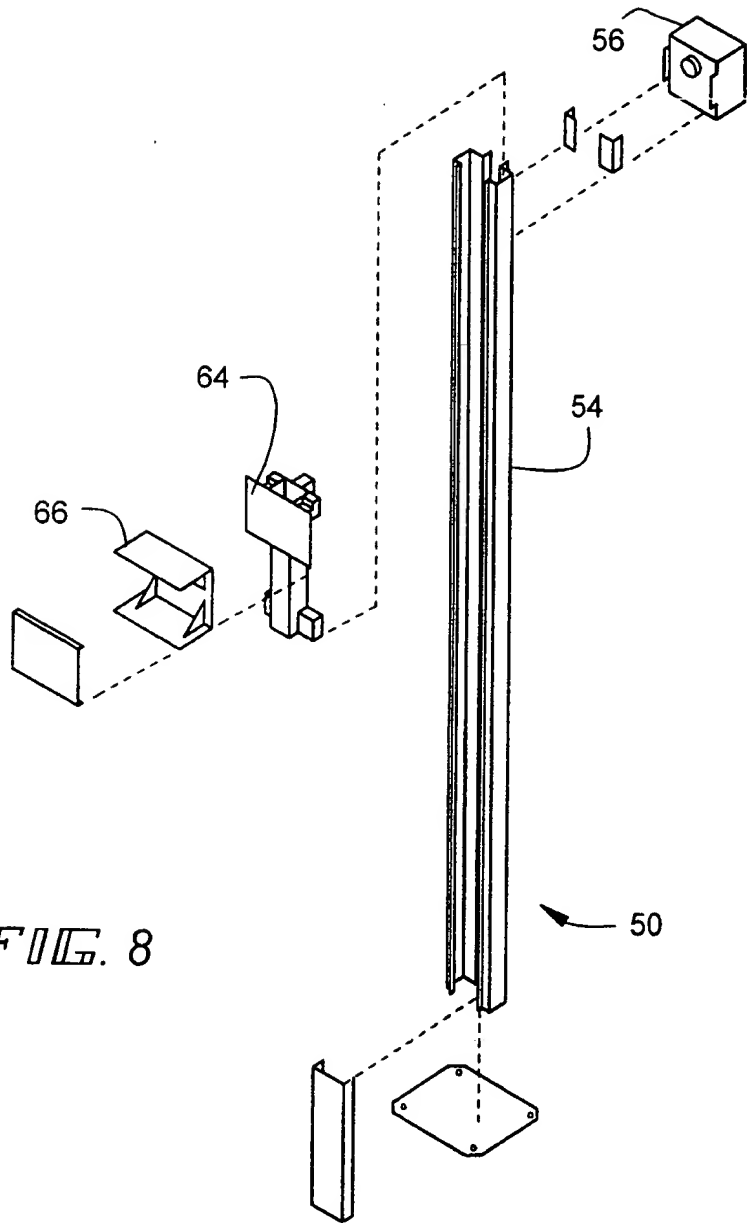
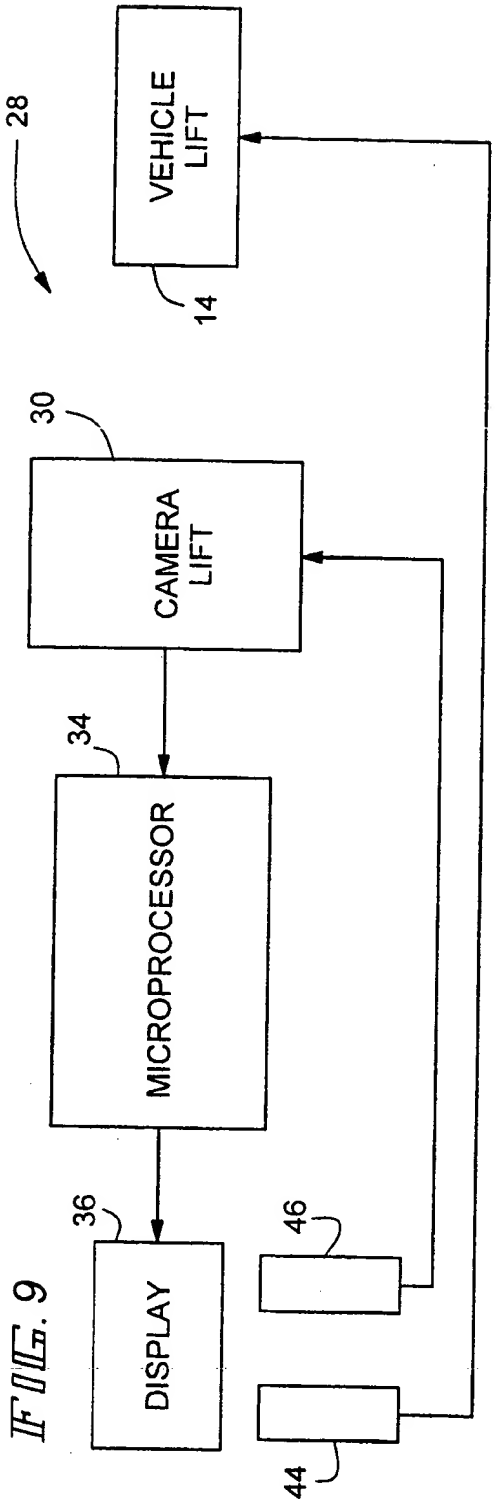


FIG. 8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14
30
CAMERA LIFT
34
MICROPROCESSOR
36
DISPLAY
46
44

FIG. 9

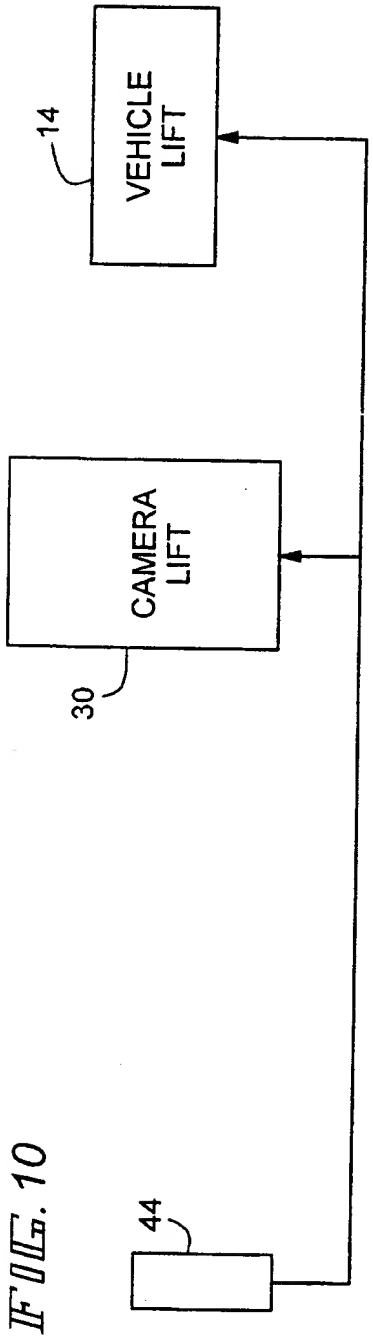
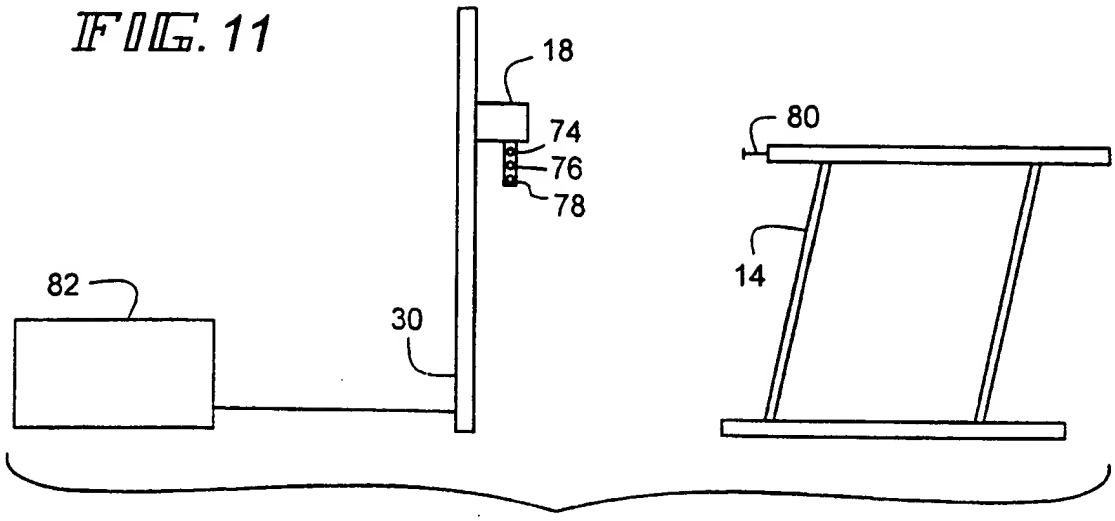

14
VEHICLE LIFT
30
CAMERA LIFT
44

FIG. 10

FIG. 11


18
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82
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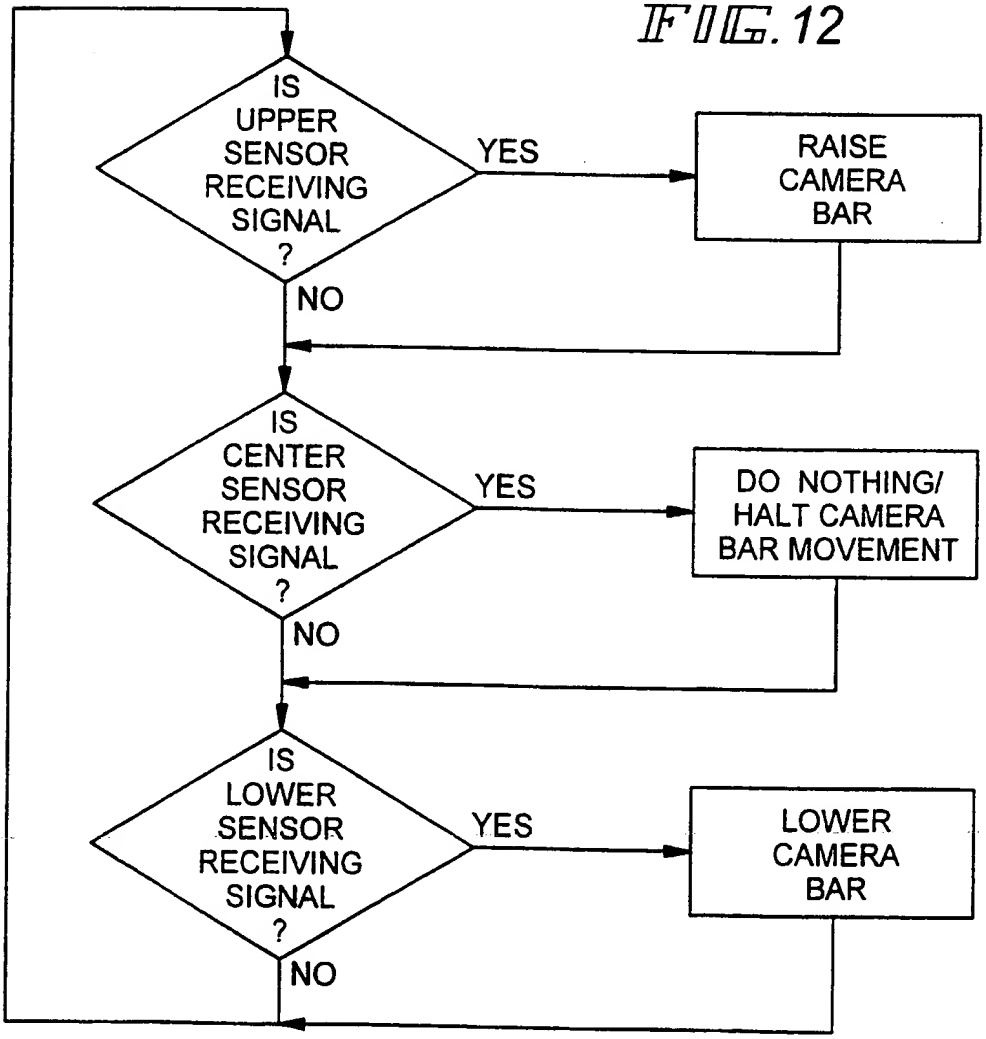
14

FIG. 12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IS CENTER SENSOR RECEIVING SIGNAL ?
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LOWER CAMERA BAR
NO

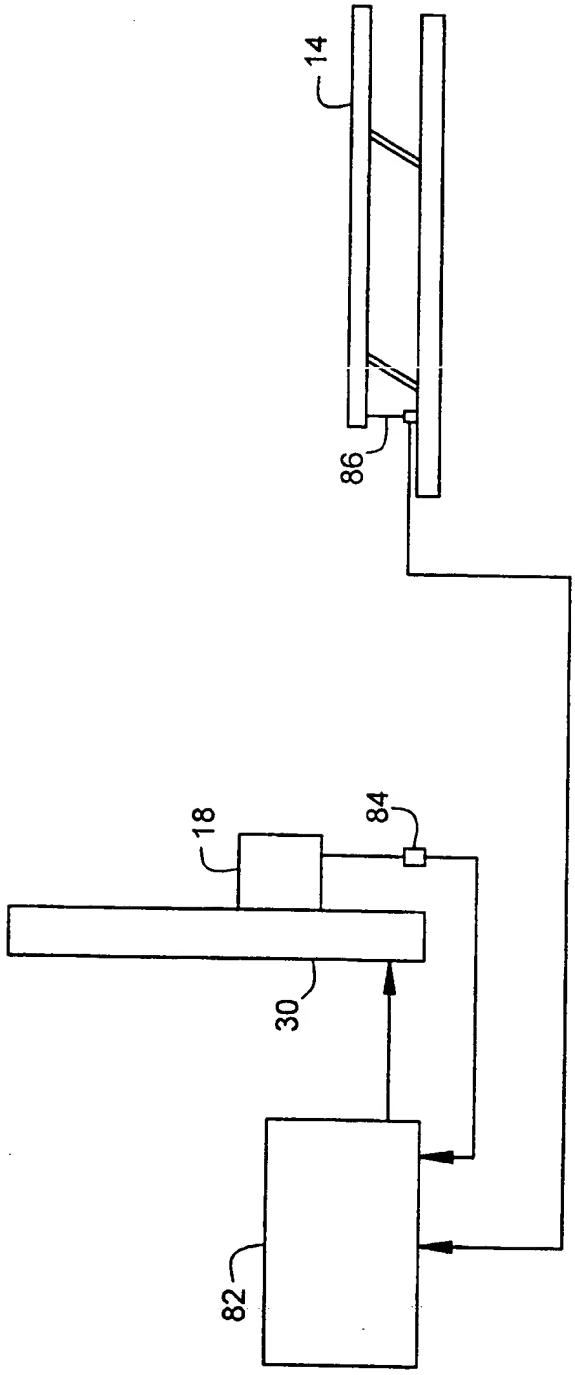

FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/14568

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G03B 17/00, 17/48, 19/00, 29/00; G01B 5/24, 11/26; H04N 7/18
US CL : 396/428, 429; 33/288; 356/139.09; 348/142, 148
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 396/419, 428, 429; 33/203.18, 288; 356/139.09 364/167.08; 348/142, 148, 154

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

USPTO APS
search terms: align?, tire#, wheel#, car, automobile, camera

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,675,515 A (JANUARY) 07 October 1997 (07.10.97), entire document.	1-5
A	US 5,724,743 A (JACKSON) 10 MARCH 1998 (10.03.98), figures 2-4, and figure 9.	1-5
A	US 5,528,836 A (STIEFF) 25 JUNE 1996 (25.06.96), Abstract, figure 2.	1-5
A	US 4,761,749 A (TITSWORTH et al.) 02 AUGUST 1988 (02.08.88), Column 3.	1-5
A	US 4,410,951 A (NAKAMURA et al.) 18 OCTOBER 1983 (18.10.83), Abstract, figure 5.	2
A	US 5,462,214 A (BUSWELL) 31 OCTOBER 1995 (31.10.95), Figure 1.	2

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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